

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal unitary member comprised of one piece of metal, said low profile unitary member having a first exterior surface adapted for receiving heat from the at least one heat generating component and having a plurality of micro tubes formed of said one piece of metal having a flattened heat transfer surface, said low profile metal unitary member having a micro tube inlet comprised of said one piece of metal and a micro tube outlet comprised of said one piece of metal, said low profile metal unitary member providing an entirely metallic thermal path for conducting heat from said first exterior surface to a heat transfer fluid contained within said plurality of micro tubes, said plurality of micro tubes being formed along an axis relative to said low profile unitary member;

an inlet tube;

cavitated inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube, said cavitated inlet end cap having a width equal to a width of the low profile metal unitary member;

an outlet tube;

cavitated outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube;

each of said plurality of microtubes being fluidly connected to adjacent and non-adjacent microtubes via said inlet end cap and said outlet end cap, said cavitated outlet end cap having a width equal to the width of the low profile metal unitary member;

means for circulating said heat transfer fluid through said inlet tube, said inlet end cap, the plurality of micro tubes of said low profile metal unitary member, said outlet end cap, and said outlet tube in a manner such that said fluid is injected into and ejected from said low profile unitary member parallel to said axis of said micro tubes; and

means for removing heat from said heat transfer fluid.

2. (Canceled)

3. (Previously Presented) The cooling apparatus of claim 1, wherein said low profile metal unitary member is in thermal contact with the at least one heat generating component, and said member is further in direct contact with said heat transfer fluid.

4. (Previously Presented) The cooling apparatus of claim 1, wherein said low profile metal unitary member is plated on an exterior surface with a metal material.

5. (Withdrawn) The cooling apparatus of claim 1, further comprising at least one thermoelectric cooling unit disposed between the at least one heat generating component and said first exterior surface.

6. (Previously Presented) The cooling apparatus of claim 1, wherein said low profile metal unitary member further comprises a plurality of fins on a second exterior surface opposite said first exterior surface adapted for receiving heat.

7. (Withdrawn) The cooling apparatus of claim 1, wherein said low profile metal member further comprises a plurality of fins or grooves on an interior surface of each of said plurality of micro tubes.

8. (Currently Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile unitary member having a flattened exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet and a micro tube outlet, said plurality of micro tubes being formed along an axis relative to said low profile unitary member;

at least one fin on an interior surface of at least one of said plurality of micro tubes;

an inlet tube;

an cavited inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube, said cavited inlet end cap having a width equal to the width of the low profile metal unitary member;

an outlet tube;

a cavited outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube, said cavited outlet end cap having a width equal to the width of the low profile metal unitary member;

means for circulating a heat transfer fluid through said plurality of micro tubes of said low profile member in a manner such that said fluid is injected into said low profile unitary member and ejected from said member parallel to the axis of said micro tubes; and

means for removing heat from said heat transfer fluid.

9. (Previously Presented) The cooling apparatus of claim 8, wherein each of said micro tubes are substantially rectangular in shape.

10. (Previously Presented) The cooling apparatus of claim 8, wherein said low profile unitary member is formed of a metal material.

11. (Previously Presented) The cooling apparatus of claim 10, wherein said metal material is in thermal contact with the at least one heat generating component, and said metal material is further in direct contact with said heat transfer fluid.

12. (Withdrawn) The cooling apparatus of claim 8, further comprising at least one thermoelectric cooling unit disposed between the at least one heat generating component and said first exterior extrusion surface.

13. (Withdrawn) The cooling apparatus of claim 8, wherein said low profile extrusion further comprises at least one fin on an interior surface of each of said plurality of micro tubes.

14.-20. (Canceled)

21. (Currently Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal unitary member comprised of one piece of metal having a first exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet comprised of said one piece of metal and a micro tube outlet comprised of said one piece of metal, said plurality of micro tubes being formed along an axis relative to said low profile unitary member, said low profile metal unitary member providing an entirely metallic thermal path for conducting heat from said first exterior extrusion surface to a heat transfer fluid contained within said plurality of micro tubes, said member having a profile of less than approximately 0.1 inches;

a cavitated inlet end cap interconnecting the micro tube inlets in fluid communication, said cavitated inlet end cap having a width equal to the width of the low profile metal unitary member;

a cavitated outlet end cap interconnecting the micro tube outlets in fluid communication, said cavitated outlet end cap having a width equal to the width of the low profile metal unitary member;

each of said plurality of micro tubes being fluidly connected to adjacent and non-adjacent micro tubes via said inlet end cap and said outlet end cap;

means for circulating said heat transfer fluid through said inlet end cap, the plurality of micro tubes of said low profile extrusion and said outlet end cap in a manner such that said fluid is injected into said low profile unitary member and ejected from said member parallel to the axis of said micro tubes; and

means for removing heat from said heat transfer fluid.

22. (Previously Presented) The cooling apparatus according to claim 21 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling the heat generating component.

23. (Previously Presented) The cooling apparatus according to claim 1 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling the heat generating component.

24. (Previously Presented) The cooling apparatus according to claim 8 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling the heat generating component.

25. (Previously Presented) The cooling apparatus according to claim 1, wherein each of said micro tubes are polygonal in cross section.

26. (Previously Presented) The cooling apparatus according to claim 1, wherein each of said micro tubes are substantially square in cross section.

27. (Previously Presented) The cooling apparatus according to claim 8, wherein said micro tubes are polygonal in cross section.

28. (Previously Presented) The cooling apparatus according to claim 8, wherein said micro tubes are substantially square in cross section.

29. (Previously Presented) The cooling apparatus according to claim 21, wherein said micro tubes are polygonal in cross section.

30. (Previously Presented) The cooling apparatus according to claim 1, wherein said micro tubes are substantially square in cross section.

31. (Previously Presented) The cooling apparatus according to claim 21, wherein said micro tubes are substantially square in cross section.

32. (Previously Presented) The cooling apparatus according to claim 1 wherein:

said low profile metal unitary member has a profile of approximately 0.1 inches.

33. (Previously Presented) The cooling apparatus according to claim 8 wherein:

said low profile unitary member has a profile of approximately 0.05 inches.

34. (Previously Presented) The cooling apparatus according to claim 1, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

35. (Previously Presented) The cooling apparatus according to claim 8, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

36. (Previously Presented) The cooling apparatus according to claim 21, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

37. (Previously Presented) The cooling apparatus according to claim 21, wherein said low profile is approximately 0.05 inches.

38. (Previously Presented) The cooling apparatus according to claim 21 further comprising:

at least one fin on an interior surface of each of said plurality of micro tubes.

39. (New) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal unitary member comprised of one piece of metal, said low profile unitary member having a first exterior surface adapted for receiving heat from the at least one heat generating component and having a plurality of micro tubes formed of said one piece of metal having a flattened heat transfer surface, said low profile metal unitary member having a micro tube inlet comprised of said one piece of metal and a micro tube outlet comprised of said one piece of metal, said low profile metal unitary member providing an entirely metallic thermal path for conducting heat from said first exterior surface to a heat transfer fluid contained within said plurality of micro tubes, said plurality of micro tubes being formed along an axis relative to said low profile unitary member;

an inlet tube;

a cavitated inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube, wherein the cavitated inlet end cap is disposed in direct contact with at least a portion of the at least one heat generating component;

an outlet tube;

a cavitated outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube, wherein the cavitated outlet end cap is disposed in direct contact with at least a portion of the at least one heat generating component;

each of said plurality of microtubes being fluidly connected to adjacent and non-adjacent microtubes via said inlet end cap and said outlet end cap;

means for circulating said heat transfer fluid through said inlet tube, said inlet end cap, the plurality of micro tubes of said low profile metal unitary member, said outlet end cap,

and said outlet tube in a manner such that said fluid is injected into and ejected from said low profile unitary member parallel to said axis of said micro tubes; and

means for removing heat from said heat transfer fluid.